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Design and Development of a Lean Material Handling System at a Refrigerator Company

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by

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Abstract

Material handling has become critically important because of improvement in the industry automation and the scale of production. US based ABC Refrigerator Company was also suffering from unreasonable material handling design in the past few years which caused the delivery delay and material wastage. The goal of this project was to reduce waste from the material handling system and improve the efficiency of the whole production. This project redesigned the new replenishment system called Material Excellence Program (MEP) which was made up of three sub-systems: Min max, Kanban, and Two Bin systems by applying, just-in-time and pull principles into the material handling process. Based on the selection criteria such as quality, usage frequency, part cost, and others. The materials in the warehouse were mainly divided into two categories: common parts and specific parts. MEP mainly focused on the common parts delivery. Time studies were conducted to record the cycle time of new replenishment system after implementation of the lean principles. The results of the project of Material Excellence Program were used at ABC. The new replenishment system was first implemented to ABC and improved the material handling system by solving problem of the smaller quantity deliveries delay and reducing waste through transportation and double handling at changeovers.

Acknowledgements

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Chapter I: Introduction

Introduction

Lean material handling methodology is currently implemented by most manufacturers worldwide. ABC is an American based refrigerator manufacturing company which has over 50 years of production history. United States based ABC Refrigerator Company was suffering from illogical material handling design in the past few years which caused the delivery delay, material wastage and safety issues. A group of industry engineers from the company had carried out Material Excellence Program (Hereinafter referred to as MEP) to improve current condition.

MEP was a program which optimized the present parts replenishment system of ABC Company. Basically, the updated replenishment system adopted lean methods such as Kanban, Two Bin and Min Max systems. Besides the methods mentioned before, the material department introduced train concept to schedule the parts delivery to assembly line as well. As the need of the feedback of the new train delivery system, a new schedule would first be applied to door assembly line in the company.

Problem Statement

United States based ABC Refrigerator Company had a poor material handling system which caused delays in manufacturing and material wastage. The goal of this project was to remove waste and improve the efficiency of the material handling system.

Nature and Significance of the Problem

Material handling has become critically important because of improvement in the industry automation and the scale of production. However, there were still hundreds of enterprises lost in production due to an unreasonable replenishment system. This project redesigned the new replenishment system through Material Excellence Program (MEP). The new replenishment system under MEP was first implemented to the door foamer line of ABC Company and improved the material handling system by solving problem of the smaller quantity deliveries delay and reducing waste through transportation and double handling at changeovers.

Objective of the Project

The objective of the project was that facilitated smaller batch sizes, reduced line side work in process inventory and kept the traffic volume balance from old material handling system to new train delivery system on door foamer assembly line.

Project Questions

1. What kind of material handling system would be designed to improve efficiency and reduce material wastage?
2. How can the material handling system move larger loads per trip than the current system?
3. How can the material handling system reduce line side WIP inventory?
4. How can the material handling system achieve this with reduced fork lift truck movement?

Limitations of the Project

Upon project completion, the most painful limitation was the delivery date of carts was delayed by outsourced company which could be regarded as time constrain. This accident led the train implementation to be postponed about two weeks which caused loss in project management view. Therefore, the relevant recommendations were posted in Chapter V.

Besides this, the team worker did not play their role at the beginning of project due to lack of communication. This caused the process of data collection to be challenging.

Definition of Terms

Lean Manufacturing. An overall methodology that seeks to minimize the resources required for production by eliminating waste (non-value added activities) that inflate costs, lead times and inventory requirements.

Kanban. Signals like cards, electronic signals, or similar mechanisms which were highly visible to all team workers. The following Formula are used to calculated Kanban Loop. Figure 1 is listed below to describe Kanban Flow.

$$Kanban\ Loop = Accum\ LT + ORDER\ LT + DEKUVERY\ LT + BS + SS$$

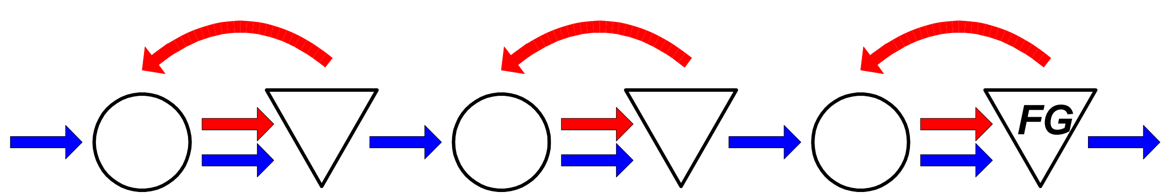


Figure 1: Kanban Flow-Signal to Produce

Two Bin System. A system that uses two containers dedicated to one component and one location (point of use). Each container is identified with the part reference, the full container quantity, the point of use and the replenishment location.

Buffer Stock. Protects against variation of consumer pull caused by demand fluctuations or instabilities of the consumer's process. This is mainly calculated from the standard deviation of the component demand—a buffer stock of 2 standard deviations would cover 95% of all like demand.

Safety Stock. Protects against the variation of replenishment from the supplier. This can be from supplier or transportation inconsistency.

Min Max System. A system that requires the supplier process to maintain inventories within predefined Minimum & Maximum limits. The formulas used in Min Max system were shown in below:

$$Minimum\ Stokc = Avergae\ Usage \times Safety\ Stock$$

$$\begin{aligned} &Maximum\ Stock \\ &\quad = Average\ usage \times (\ Accum\ lT + Order\ LT + Delivery\ LT \\ &\quad + Buffer\ Stock + SS) \end{aligned}$$

In this way, the supplier can freely deliver within the indicated Min/Max range. In Min Max system, unlike Kanban, the delivery number does not have to be fixed.

Part. Component or material used in ABC Company.

Product. The assembly into which a part is fitted which are lids for each models of freezers or refrigerator

Pack. The container in which the part is delivered to the line

Delivery point. The point at which parts are delivered to the line

Picking Point. The point at which a part is loaded to the train

Train. A tug and tractor unit, plus a number of wagons or trailers

PFEP. In ABC Company, the data base of all components named PFEP which stands for Plan for Every Part. PFEP contains all supply information of necessary parts which are used in each assembly line. Although, simply creating PFEP database does not added any value alone. It is an essential tool to support the implementation and maintenance of a lean material supply strategy in the long term.

Bill of Material. A list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product.

Summary

This chapter mainly gave a brief introduction of this capstone project. It stated the problem statement as well as nature and significance. Furthermore, the objective of this project was given to describe the short- and medium-term effects on the target area. Limitation of the project showed the unsatisfactory part of this project, which could be viewed as the improvement in the future. At the end, the essential definition and figure of terms were listed to help readers get a better understanding when reaching the following chapter.

Chapter II: Background and Review of Literature

Introduction

This chapter covers the background knowledge necessary to complete this project. The literature related to the problem looks at similar work performed in other industries. And the literature of methodology provided a reference to this project.

Background Related to the Problem

ABC is an American based company that has mainly manufactured different models of freezers and refrigerators for over 50 years. There were four assembly lines in ABC Company. Line 1 and 2 were designed to produce different kinds of refrigerators. Line 3 and Line 4 were mainly used to produce the freezers. Additionally, door assembly line was separated from these four lines. It was built to produce lids of freezers and refrigerators ahead of the normal shift schedule for fulfilling the need of the other four lines. The final stage of Material Excellence Program is applying train delivery system on each line successfully in the plant. However, due to time, labor and other constrains, this project was only focused on application on door foamer line.

Literature Related to the Problem

In a manufacturing company, material handling is always the most worthy part to be studied in the daily operation. Just as R. Navon and O. Berkovich (2005) stated that material resources took a great portion of a project's cost which made material resources become an tempting something to manage and control in the manager's view as well. They also described that a reasonable way to control and manage material could increase productivity by 6% or even more. Therefore, the question is: what kind of material handling system did a company desire for? A proper material handling system did not just mean parts could be delivered to the right place on time. What was more important was the whole system needed to ensure components could be sent to assembly line safely in an efficient way.

Different methods and tools were designed by engineers to reach these two goals: safe and efficient. For example, in Perttular et al.'s (2006) study, the time of material transfer needed with the elevator was 41% of the time by carrying manually at a construction site. Manual material transfer replaced by using elevators was an improvement in health and safety aspects as well.

As stated above, material handling should be put in high value in operation management. A lean material handling system reduced the cost of the product by minimizing idle time and improving the work environment.

Literature Related to the Methodology

Along with the development of the lean manufacturing, an increasing number of companies started to apply lean principles in variety aspects of production process. However, during the application of lean principles, just as Dr. Lu (1986) said in his book, Kanban just-in-time at Toyota: Management begins at the workplace, a lot of team members in the workplace would think they did not have the capabilities and enough labor to apply lean manufacturing. Conversely, if Team Members started to reset the manner of things flow and arrangement of storage, they would not only accomplish what they think they cannot finish, but own a little bit of extra time.

To reduce the waste of material and waiting time, pull system should be in place of push system. “Pull system means that material is drawn or sent for by the users of the material as needed” (Hall, 1983, p. 20). In pull system, the most well-known method of control utilized is Kanban system. “Kanban is a Japanese word that means ‘card’ or ‘signal’ ” (Louis, 1997, p. 10). However, the company should never implement the Kanban system out of context; otherwise, their efforts will be in vain.

When it came to details of application of lean manufacturing, time standard would be required in the planning phase of a new replenishment process (Stephens & Meyers, 2010). Time standard time contributed to control the actual cycle time and lead time. Furthermore, the transportation which used into new replenishment system will need to be designed as well. There was good example in *Materials handling: Principles and practice* which is tractor–trains (Allegri, 1984). This type of transportation allowed large warehouses and manufacturing plants move a great number of unit load daily.

Summary

This chapter mainly explained the background of the problem that provided the basic information about this project. Additionally, literature related to problem explained the urgency of studying this project under the environment of global industrial engineering. The last part of this chapter was literature related to the methodology, which gave a detailed explanation of the methodology that could be used to accomplish this capstone project. The next chapter describes the whole process of applying this project in detail.

Chapter III: Methodology

Introduction

This chapter will mainly describe the design of this project, the process of data collection, and methods that are used to analyze data. The principle of MEP is introduced in this chapter as well.

Design of the Study

In this project, a quantitative approach was mainly used for getting a satisfying result. The main reason for using a quantitative approach was that parts categorization was the most critical step which required several material characteristics like cost, volume and size of every component assembled on lids of freezers or fridges. The cycle time of consumption of different types of materials could vary from each other. This had to be analyzed in quantitative approach to decide delivery cycle time for meeting the need of door assembly line. Figure 2, Figure 3, and Figure 4 are the flow charts of train delivery implementation schematic. The process of this project could be divided in to five phases. Phase I, Define Delivery Point, was collecting necessary information. In phase II, Set Train Parameters, a couple of factors needed to be calculated or set up. Phase III was Model the Train Options which mainly test if the options could work smoothly to replace the old delivery system. If yes, the project would move on to phase V which was Implement Train Delivery System. However, if the answer is no, parameters would need to be revised in phase IV. The final stage of train configuration will be shown in Figure 4 as below.

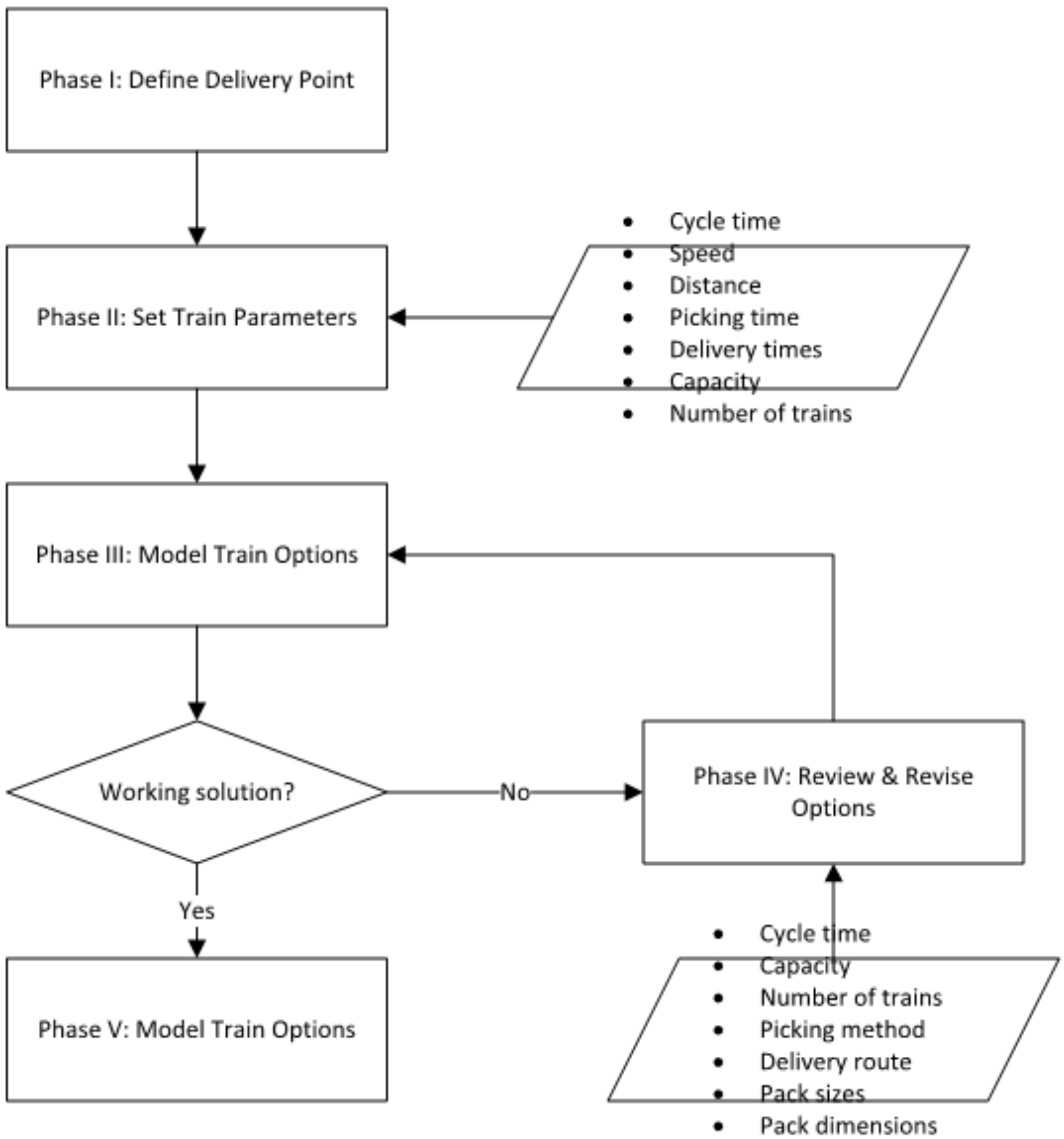


Figure 2: Train Delivery Implementation Schematic Flow Chart

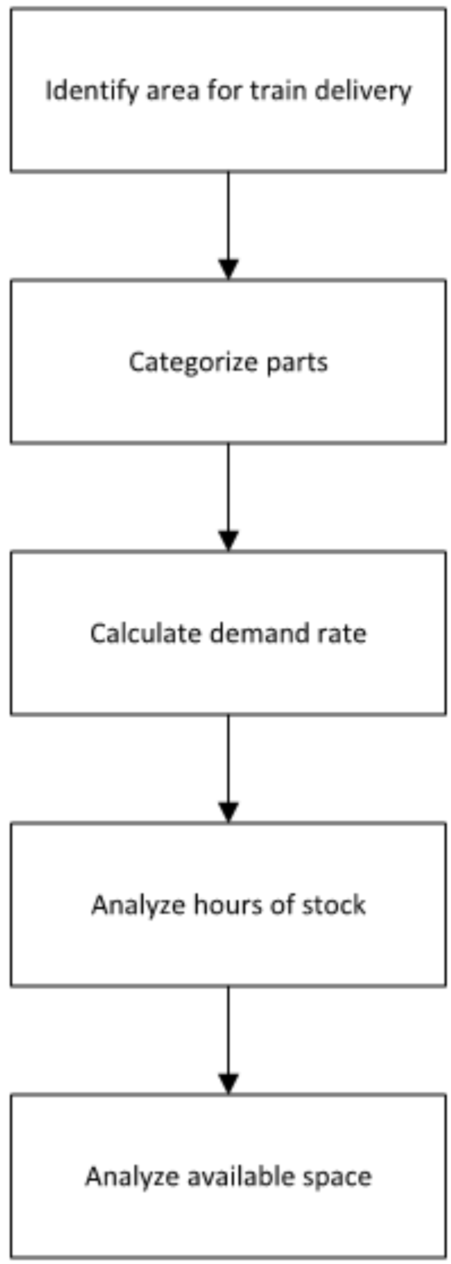


Figure 3: Phase I Level 1 Flow Chart

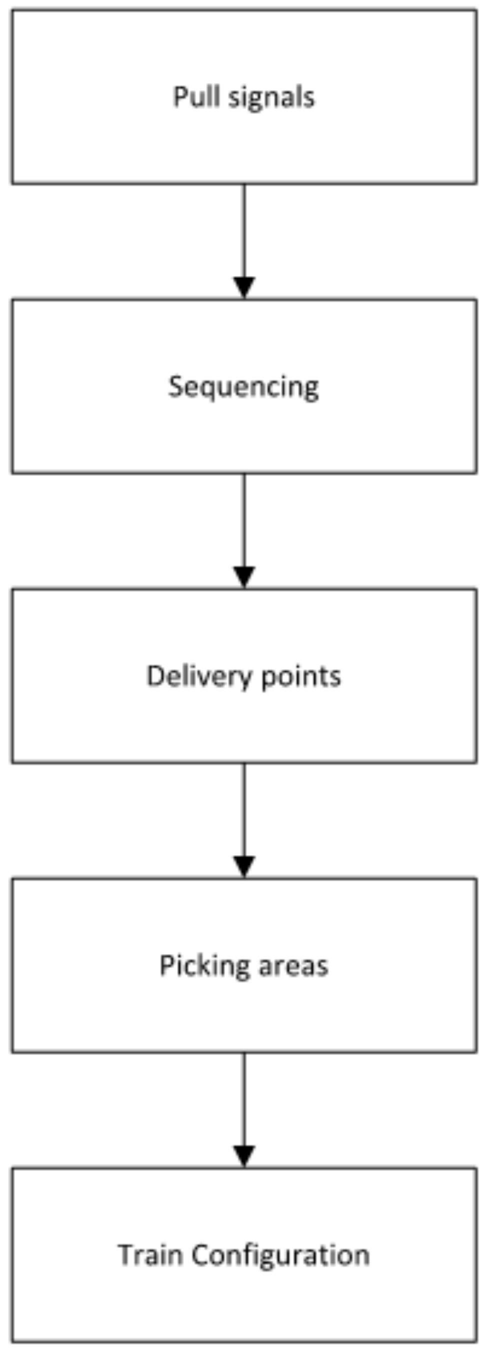


Figure 4: Phase II Level 1 Flow Chart

To implement the train concept, the requirements needed to be clearly defined at first. For all the material parts, the following items should be considered before applying train delivery system:

1. Clearly defined delivery point
2. Robust ‘pull’ trigger mechanisms- Visual or Electronic
3. Standardized container quantities
4. Defined delivery routing
5. Consistent delivery cycle time
6. Well configured picking and storage locations
7. Warehouse layout needs to be optimized for picking
8. Real time transactions like bar, coding and Wi-Fi
9. Standard operating procedures

Once the basic parameters had been determined then it came to Phase V modeling the possible train delivery options. An excel model of the train delivery routed based on a preferred solution like target cycle time, number of trains etc. could be created. Review the train cycle time and capacity armed at changing variables timely until a workable solution had been developed. The example model train option is shown as Figure 5.

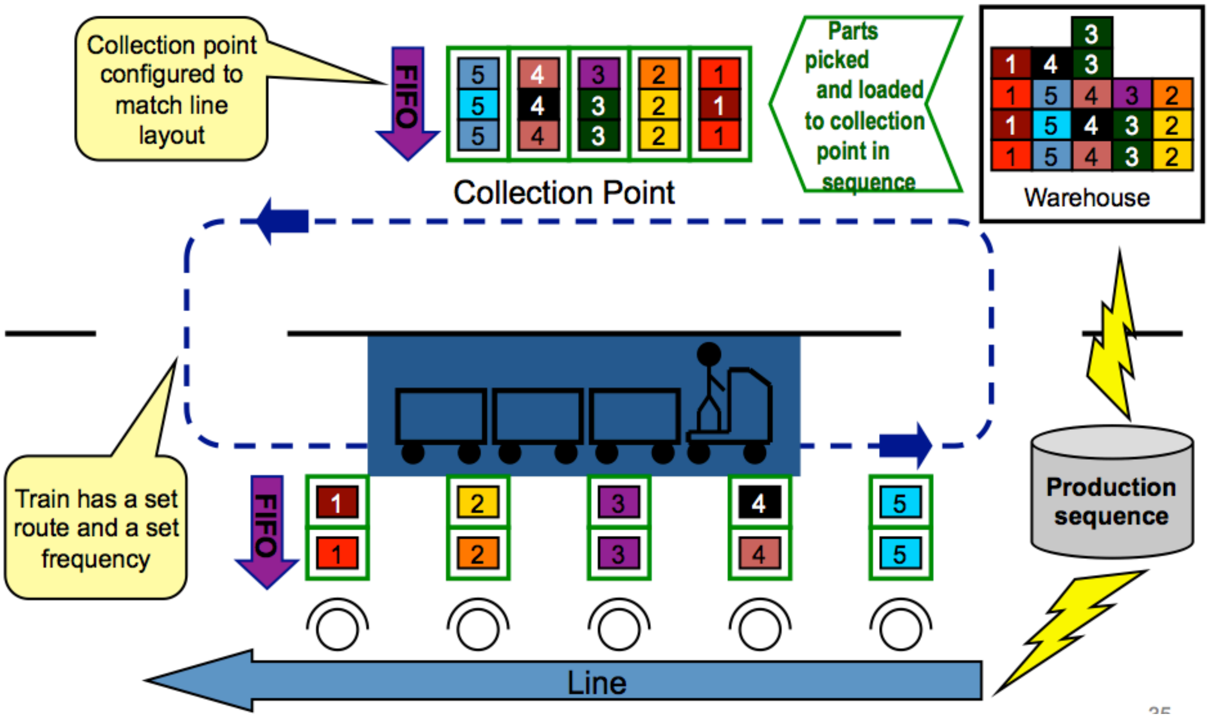


Figure 5: Sketch Map of Model Train Option

Data Collection

As Figure 4 shows above, data supported to this project mainly were collected in phase I and phase II. In phase I, Define Delivery Points, the critical data was information of component. The activities for getting the original information included going through Bill of Material in ERP system of ABC Company and listing the parts which are used in the target area. The following step was analyzing each part used in this area and updating the PFEP if needed.

Time Study and interviews with the team members were conducted in phase II. They were used to get the data which would be used in setting up or comparing train parameter between the old and new material handling system like cycle time, speed, distance, picking time, delivery time, capacity and number of trains. Time Study was done by two or more people to minimize individual error. Figure 6 and Figure 7 were the Time Study templates for picking and delivering on door foamer line respectively.

Table 1: Picking Time Study Template

Door Foamer Forklift Picking Time Study					
Model			**Picker**		**Time**
Parts description	**Parts Number**	**Total boxes**	**Time (sec.)**	**sec/part**	**Notes**
SUM					
AVERAGE TIME (sec./part)					

Table 2: Delivery Time Study Template

Door Foamer Train Delivery Time Study

Model: **Driver:** **Date:**

Train	Start Point	End Point	Driving Time (sec.)	Unload Time (sec.)	Distance (ft.)	Carts	Notes
	Sum						
	AVERAGE TIME(ft./sec.)						

As for the interview part, the supervisor and lead person were expected to participate because they have a better understand of the process of the old material transfer system. Other team members that worked in the target area could be considered to take part in the interview as well to find out the issues which would be easily ignored. Interview questionnaire is shown in Appendix A.

Data Analysis

After data was collected, raw information needed to be analyzed to model Train options. Same as the data collection part, data would be analyzed in Phase I and Phase II, which happened before modeling train options. It's worth noting that Time Study Form could be used to analyze data in Phase II as well.

Phase I: Define delivery points.

1. Identified the area of delivery before collecting information.
2. Categorized the components from the target area. The flow chart was shown in Figure 6.

   All components and materials were classified into three types:

   - Out of Scope: Parts not be included in train deliver due to size, weight or current delivery method like conveyors.
   - Common or High Usage parts: Parts used on all or a high percentage of product volume.
   - Order specific parts: Parts those are specific to one or only a small number of product variants.

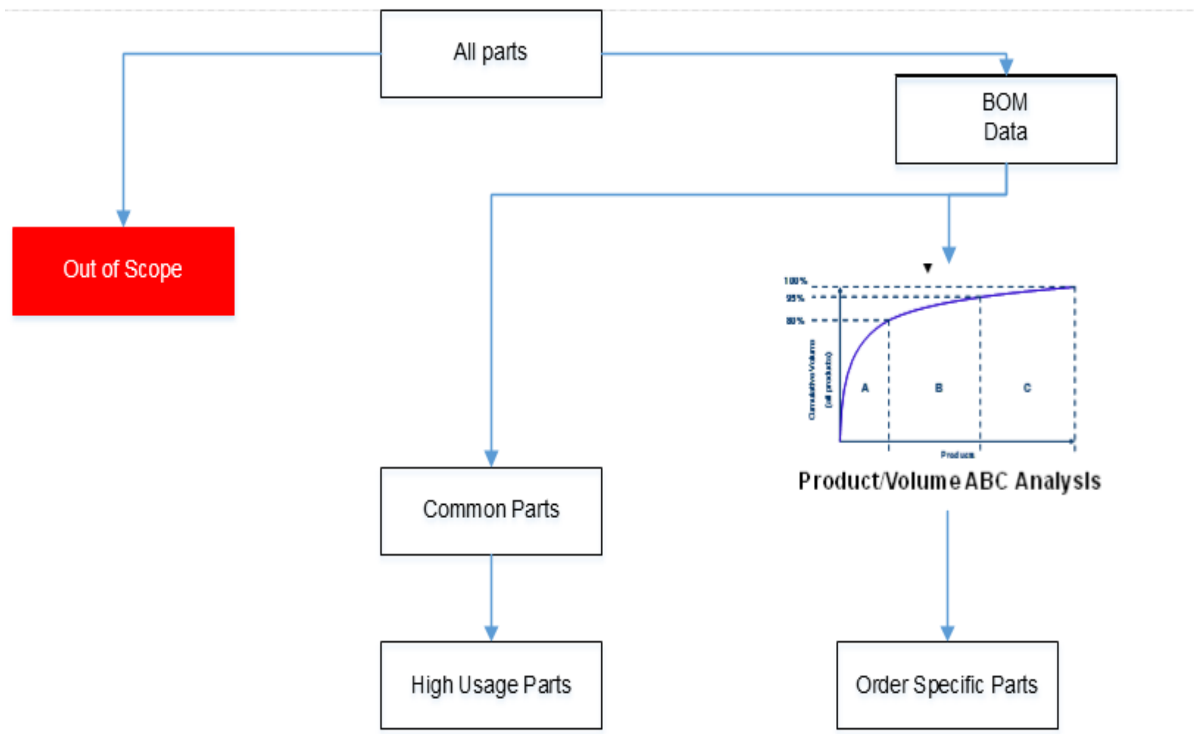


Figure 6: Sketch Map of Model Train Option

3. Calculated demand rate. Demand Rate (DR) referred the rate at which a part was consumed by the production line and typically in parts/hour.

$$DR = BOM\ Quantity(part\ quantity\ per\ product) * Production\ Line\ Rate(products\ per\ hour)$$

4. Analyzed hours of stock. Besides the demand rate of each part, pack per container quantity which was supplied to the line and pack per container dimensions needed to be ascertained as well. After given demand rate and pack quantity, the hours of stock per container could be calculated as the formula showed below:

$$Hours\ of\ stock = \frac{\frac{Pack}{Container\ Quantity}}{\text{Demand Rate}}$$

5. Analyzed packs delivered per hour. As each delivery point, the average number of individual packs which would be delivered per hour for all parts at that delivery point need to be calculated additionally. The calculation sample was shown in Figure 7.

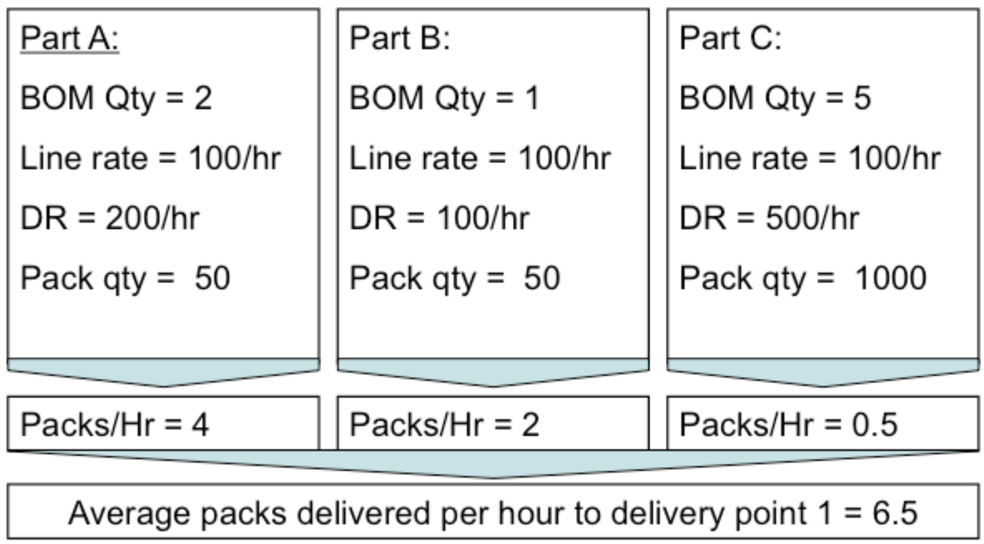


Figure 7: Calculation Sample

6. Analyzed available Space. Using the pack dimensions to calculate the maximum number of packs per part could physically be held at a delivery point which also could show the part with the minimal amount of stock at each delivery point.

Phase II: Set train parameters.

1. Cycle Time. The train delivery system was a replenishment system, so cycle time had to be less than the minimum stock of parts held on the line. Type and related time of the parts could be known from analyzing the space requirements at each delivery point in step 6 of defining the delivery

points. It was critical important to build safety factor into the train cycle time which could absorb the possible variations in the cycle time.

Take an example from Appendix 1, Part A was the part with the lowest hours of stock for the proposed train route.

Part A:

BOM QTY = 2 per product

Line Rate = 100 products per hour

Demand Rate = 2 x 100 = 200 per hour

Quantity per Box = 50

Box size = 0.5m x 0.5m x 0.5m

Available space at the line = 0.5m x 2m

Maximum number of boxes = 4

Hours of Stock for Part A = 200/ (50 x 4) = 1

Phase II: Set train parameters continued.

1. In this example, Part A had a maximum of 1 hour stock on the line which meant the train system must replenish part A at least once per hour. Meanwhile, the cycle time for the train of 1 hour should leave margin for error in the real situation. Thus, that would leave 15 minutes in case of mishandling during the delivery process. In the final, the cycle time would be set as 45 minutes.
2. The speed of train. The speed at which the train would operate, usually in ft./second.

3. Distance. The distances which the train will have to travel between picking and delivery points.
4. Picking time. The average time it takes to pick 1 pack and load it to the train.
5. Delivery time. The average time it takes to unload 1 pack from the train and load it to the delivery point.
6. Capacity. The maximum number of packs that a train can carry in one cycle which may be complicated if pack dimensions vary significantly.

Phase II: Set train parameters continued.

1. Number of trains. The number of trains planned or available to support the system.

Based on the explanation of each parameter, the following figure showed how the parameters were analyzed and set up. The formula which used to analyzed data will be shown in the following chapter.

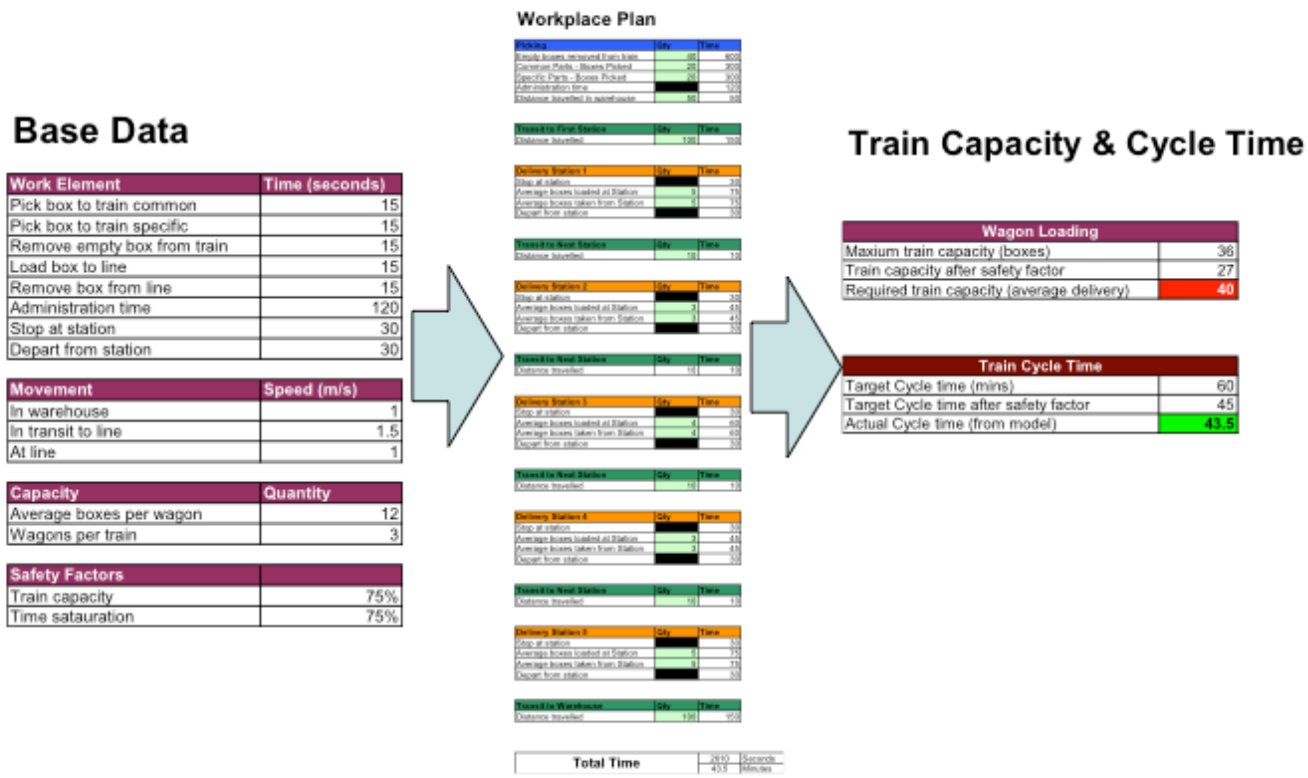


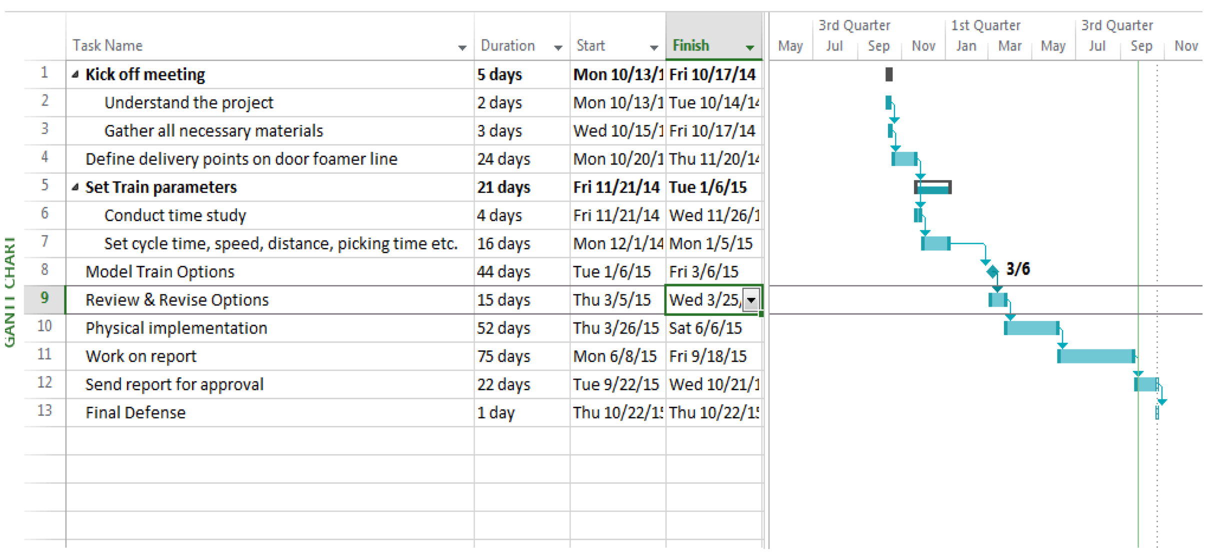
Figure 8: The Process of Data Analyzing

Budget

The basic tool used in this project like stop watch, wheel measurement and others were provided by ABC Company. The cost of train and flat cart which were outsourced to another company are counted in the budget of Material Excellence Program.

Timeline

The whole project were divided into five parts based on the five phase of Train delivery implementation schematic flow chart. The milestone was modeling train concept. Started with this stage, all the information was finishing collected and the rudiment of train was created as well.



	Task Name	Duration	Start	Finish
1	**Kick off meeting**	**5 days**	**Mon 10/13/1**	**Fri 10/17/14**
2	Understand the project	2 days	Mon 10/13/1	Tue 10/14/1
3	Gather all necessary materials	3 days	Wed 10/15/1	Fri 10/17/14
4	Define delivery points on door foamer line	24 days	Mon 10/20/1	Thu 11/20/1
5	**Set Train parameters**	**21 days**	**Fri 11/21/14**	**Tue 1/6/15**
6	Conduct time study	4 days	Fri 11/21/14	Wed 11/26/1
7	Set cycle time, speed, distance, picking time etc.	16 days	Mon 12/1/14	Mon 1/5/15
8	Model Train Options	44 days	Tue 1/6/15	Fri 3/6/15
9	Review & Revise Options	15 days	Thu 3/5/15	Wed 3/25,
10	Physical implementation	52 days	Thu 3/26/15	Sat 6/6/15
11	Work on report	75 days	Mon 6/8/15	Fri 9/18/15
12	Send report for approval	22 days	Tue 9/22/15	Wed 10/21/1
13	Final Defense	1 day	Thu 10/22/1	Thu 10/22/1

Figure 9: Microsoft Project Time Line

Summary

From this chapter, the design of this project was being stated in Figure1. Besides, the process of data collection and the techniques which were used to analyzing data was described as well. Next chapter would use all the raw data and analysis to modeling the train option.

Chapter IV: Data Presentation and Analysis

Introduction

The actual data which was stating in last chapter will be presented here. Additionally, the formula which used to be analyzed raw data will be explained in second section as well.

Data Presentation

In this part, the actual data which collected on door assembly line would be shown under different categories.

1. Categorize parts. It stated in chapter III that all the parts would be classifies into three types based on frequency of use, part size and cost of part. There was only one part in out of Scope part list which is PAPER DOOR U17 ARC. The size and weight of this part is way over the capacity of the train. After routine meeting, engineers decided to add this delivery job to plastic forklift driver for this stage. Therefore, only common parts and specific parts were listed below. Color code was applied in spread sheet to show the different characters of part clearly. U19 and NSF are specific models which produce not as frequent as the regular model. Services model referred the model which only produced for customized order.

Table 3: Door Foamer Line Regular Model Part List

HANDLE FORLIFT ELIMINATION							
Model:	Regular				Driver:		
	U19-NSF				Time:		
	Services Model						
No.	Part Description	Part Number	Per Unit		Quantity (/box)	Location	Note
			Regular Door	Revisable Door			
1	ANCHOR SCREW #10 ADH	240537301	2	4	1000	R5H11	
2	BEARING TOP HING WHITE/NAT	216970802	1	2	5000	R3Q20	
3	BLOCK EPS 1.5" REV CORNER SEAL	297279701	2	2	1500	Oven 4	
4	BLOCK EPS 2.5" REV CORNER SEAL	297382300	2	2	1500		
5	CLIP EVAPORATOR	297007500	1	1	5000	R9E34	
6	DOOR BEARING VYNYNE NYLON	297415900	1	1	1600	R1D31	
7	DOOR STOP REVERSIBLE	297416200	1	1	396	R5R11	
8	FOAM BLOCK SPACER 0.75*1.5*0.75	216745351	9	9	55680	R4P20	
9	FOAM FILL FLAPPER-DOOR	297215001	1	1	4000	R9F30	
10	HANDLE RECESSED WHITE	297034200	1	1	950	R9D30	
11	HARN ASSY DOOR BLACK FUZI UI	808825502	1	1	75	Warehouse	
12	LOCK ASSY UPRIGHT	297318600	1	1	250	R3H31	
13	REINFORCEMENT CURVE BOTTOM RH	297385600	1	1	400	R7F51	
14	REINFORCEMENT CURVE BOTTOM LH	297385602	1	1	450	R4T10	
15	REINFORCEMENT CURVE TOP LH	297385603	1	1	500	R5M11	
16	REINFORCEMENT CURVE TOP LH	297385601	1	1	500	R9N30	
17	RETAINER ASSY WITH TAPE	A01101301	1	1	110	R5T21	
18	SCR FH #8-16X.0750 TYPE P TWIN	297197500	2	2	11000	R9R22	
19	SHIELF LOCK DOOR	297366011	1	1	500	R4N51	
20	SPRING CLIP	297213300	1	1	4000	R4N11	
21	TAPE 2 IN MASKING 3M 201 PLUS	808509901	3	3	24	R8A11	
22	TAPE FIL 1" 60 YD RL 3M 8915	129664	8 inches	8 inches	36	R9L31	
23	TAPE FLAT BACK 1.00*60 YD	216859400	3 inches	3 inches	36	R9J33	
24	VENT TAPE "1.25*1.25"	216403300	3	3	80640	R6P11	
25	VENT TAPE 2.00*4.5	216578900	1	2	11420	R8C10	

Table 4: Door Foamer Line U19/NSF Model Part List

HANDLE FORLIFT ELIMINATION								
Model:	Regular				Driver:			
	U19-NSF				Time:			
	Services Model							
No.	Part Description	Part Number	Per Unit		Quantity (/box)	Location	Note	
			Regular Door	Revisable Door				
26	5/8" PERMAGUM	297045200			40	R4J10		
27	ANCHOR COMMERCIAL	297315400	2	2	500	Wacosa new	Tuesday/week Dirctly from supplier.	
28	BEARING TOP HINGE GRAY	216970801	1	1	5000	R7N11		
29	BEZEL-LOCK	216468700	1	1	4000	Warehouse		
30	DOOR BEARING NYLENE 311 HS	297302900	1	1	1600	R9F15		
31	DOOR REINFORCEMENT	297303000	1	1	400	R7R20		
32	DOOR STOP LEFT HIDDEN	297302801	1	1	320	R1G25		
33	DOOR STOP RIGHT HIDDEN	297302800	1	1	320	R1H22		
34	END CAP LH	297300301	1	1	30	R8L51		
35	END CAP RH	297300300	1	1	30	R7B11		
36	FOAM BLOCK SPACER 0.75*0.75*2.38	216745353	9	9	33408	Oven 4		
37	HARN ASSY DOOR WHITE FUZI UI	808825501	1	1	75	R3J10		
38	HOLE PLUG FILL HOLE GREY	216403701	1	1	7000	R1H34		
39	LOCK ASSY	216362700	1	1	200	R3J10		
40	PIZZA SAVOR	297421000	9	9	1000	R6B10		
41	REVERSIBLE LOCK BLOCK	297049600	1	1	500	Oven 4		
42	RIVET 1/8"*0.172	297121202	1	1	30000	R9D10		
43	SCR #8-18*1/2 HI-LO BLUNT ROHS	124857-01	4	4	12500	R9N32		
44	TAPE 2" POLY TESA 4298 IVORY	216917300	12	12	36	R9H30		
45	TAPE POLY 1.00	216611100	3 inches	3 inches	72	R9H31		
46	DOOR STOP LH STEPPED	297257002			500	R3G10		
47	BEARING BTM HINGE	297006800			5000	R5F11		
48	ANCHOR SCREW #8 WH ADH	297048000			4900	R4L10		
49	PAPER DOOR U17 ARC	297386400			728	DU7 40A		
50	HARNESS DOOR WH(RPLCS 2972631)	808419301			40	R4F21		
51	HARNESS DOOR BK(RPLCS 2972631)	808419302			40	R5D20		

2. Time Study Form and Interview question. Time Study was conducted on old and new material handling system respectively to compare the time which reduced in this project. Table 5, Table 6, and Table 7 are picking time study for door foamer line.

Table 5: Door Foamer Forklift Picking Time Study for Regular Door

Door Foamer Forklift Picking Time Study						
Model	**Regular door**		**Picker**	**Travis**	**Time**	**1/27/2015**
Parts description	**Parts Number**	**Total boxes**	**Time (sec**	**sec/part**	**Notes**	
SCR FH #8-16X.750 TYPE P TWIN	297197500	1	240	240		
ANCHOR SCREW #10	240537301	4	300	75		
SHIELF LOCK DOOR	297366011	4	300	75		
SPRING CLIP	297213300	1	180	180		
TAPE 2 IN MASKING 3M 201 PLUS	808509901	1	204	204		
TAPE FIL 1" 60 YD RL 3M 8915	129664	1	90	90		
TAPE FLAT BACK 1.00*60 YD	216859400	1	95	95		
VENT TAPE "1.25*1.25"	216403300	1	100	100		
VENT TAPE 2.00*4.5	216578900	2	160	80		
BEARING TOP HING WHITE/NAT	216970802	1	220	220		
BLOCK EPS 1.5" REV CORNER SEAL	297279701	1	210	210		
BLOCK EPS 2.5" REV CORNER SEAL	297382300	1	238	238		
CLIP EVAPORATOR	297007500	1	260	260		
DOOR BEARING VYNYNE NYLON	297415900	2	360	180		
DOOR STOP REVERSIBLE	297416200	4	400	100		
FOAM BLOCK SPACER 0.75*1.5*0.75	216745351	1	600	600		
FOAM FILL FLAPPER-DOOR	297215001	1	590	590		
HANDLE RECESSED WHITE	297034200	2	450	225		
HARN ASSY DOOR BLACK FUZI UI	808825502	8	780	98		
LOCK ASSY UPRIGHT	297318600	5	500	100		
REINFORCEMENT CURVE BOTTOM RH	297385600	4	180	45		
REINFORCEMENT CURVE BOTTOM LH	297385602	2	480	240		
REINFORCEMENT CURVE TOP LH	297385603	2	360	180		
REINFORCEMENT CURVE TOP LH	297385601	3	450	150		
RETAINER ASSY WITH TAPE	A01101301	6	750	125		
SUM		60	8497	4700		
AVERAGE TIME (sec./part)		142				

Table 6: Door Foamer Forklift Picking Time Study for U19/NSF Door

Model	U19, NSF		Picker	Adam	1/27/2015
Parts description	Parts Number	Total boxes	Time (sec.	sec/part	Notes
RIVET 1/8"X.172	297121202	1	200	200	
SCR #8-18X1/2 HI-LO BLUNT ROHS	124857-01	1	195	195	
TAPE 2" POLY TESA 4298 IVORY	216917300	1	280	280	
TAPE POLY 1.00	216611100	1	280	280	
BEARING TOP HINGE GRAY	216970801	1	320	320	
BEZEL - LOCK	216468700	1	360	360	
HOLE PLUG FILL HOLE GREY	216403701	1	250	250	
BEARING DOOR REVERSIBLE	297302900	1	270	270	
DOOR STOP LH HIDDEN	297302801	2	450	225	
DOOR STOP RH HIDDEN	297302800	2	475	238	
SUPPORT, PAPER (PIZZA SAVER)	297421000	6	350	58	
U19 DOOR REINFORCEMENT	297303000	2	600	300	
5/8" PERMAGUM	297045200	4	760	190	
ANCHOR COMMERCIAL	297315400	5	500	100	
LOCK ASSY	216362700	2	450	225	
EPS BLOCK	297279701	1	350	350	
SEALER	096871	4	450	113	
ANCHOR LOCK NSF	216423201	1	180	180	
END CAP LH	297300301	10	960	96	
END CAP RH	297300300	10	1050	105	
REVERSIBLE LOCK BLOCK	297049600	2	750	375	
FOAM BLOCK SPACER .75X1.5X.75	216745351	1	790	790	
SUM		60	10270	5499	
AVERAGE TIME (sec./part)		171			

Table 7: Door Foamer Forklift Picking Time Study for Service Model

Model	Service Model		Picker	Adam	1/27/2015
Parts description	Parts Number	Total parts	Time	sec/part	Notes
DOOR STOP LH STEPPED	297257002	1	60	60	
BEARING BTM HINGE	297006800	1	75	75	
ANCHOR SCREW #8 WH ADH	297048000	1	160	160	
HARNESS DOOR WH(RPLCS 2972631)	808419301	3	75	25	
HARNESS DOOR BK(RPLCS 2972631)	808419302	3	80	27	
SUM		9	450	347	
AVERAGE TIME (sec./part)		50			

The interview questionnaire was attached in Appendix A. The answer collected from interview to lead person and supervisor of door assembly line were listed below.

1. Have you ever experienced the situation of lacking of component to assemble?

   Answer: Yes.

a. If yes, how often and how long did you wait for the material coming?

   Answer: Lacking of component to assemble happened two times in past month. It wasted 15 minutes each time for workers to get the right components and restart to assemble lid.

2. After implement the new delivery system, how often did you expected the material been delivery per shift?

   Answer: If possible, I would like the material to be delivered at least twice a shift.

3. Where did you want the material handler place the parts in your convenience?

   Answer: As close as the work station which can reduce manually moving material.

4. Were you lacking of racks to hold the material buffer? If yes, what kind of racks are you prefer to use?

   Answer: Yes. The racks which hold different screw was not wide enough to place boxes. The rest of part had to be placed on the floor which could cause safety issues.

5. Any questions or suggestions regard this project?

   Answer: The color code could be applied on parts' tag to distinguish the location of component as a visual control.

Data Analysis

Considered the answer from lead person of the frequency of delivery and other factors, a decision made by MEP group was that the door foamer train would be delivery twice a shift. Since the whore shift is 8 hours, the capacity of the component on one delivery need to cover the 4 hours’ consumption on door assembly line.

Based on the part list shown in Figure 11, Figure 12, and Figure13, the spread sheet was created to analyzing that how many parts would be needed per delivery.

Table 8: Door Foamer Parts Spread Sheet

		Color Code		Regular door							
				U19-NSF							
				Common parts							
				Services Model						800	
Cart #		Door Foamer Train			Per	Box Capacity not including open box	Total boxes/ 4 hours	Capacity	Box QTY	1st Shift	Location
				Other models							
cart 1	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN							
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"							
	1 run	Door Foamer	297213300	SPRING CLIP							
	1 run	Door Foamer	808509901	TAPE 2 IN MASKING 3M 201 PLUS							
	1 run	Door Foamer	129664	TAPE FIL 1" 60 YD RL 3M 8915							
	1 run	Door Foamer	216859400	TAPE FLAT BACK 1.00 X 60 YD							
	1 run	Door Foamer	216578900	VENT TAPE 2.00X4.500							
	1 run	Door Foamer	297215001	FOAM FLAPPER							
	1 run	Door Foamer	216970802	BEARING TOP HINGE							
	1 run	Door Foamer	297007500	CLIP EVAPORATOR							
	1 run	Door Foamer	297415900	REVERSIBLE BEARING DOOR							
	1 run	Door Foamer	297366011	SHIELD LOCK ARC DOOR							
	1 run	Door Foamer	240537301	ANCHOR SCREW #10							
	1 run	Door Foamer	297034200	HANDLE RECESSED WHITE							
Cart 2	2 runs	Door Foamer	297318600	LOCK ASSY UPRIGHT							
	2 runs	Door Foamer	297385600	CURVE DOOR REINFORCEMENT RH/LH							
	2 runs	Door Foamer	297385602	REINFORCEMENT CURV BTM LH							
	2 runs	Door Foamer	297385603	REINFORCEMENT CURVE TOP LH							
	2 runs	Door Foamer	297385601	CURVE DOOR REINFORCEMENT RHTOP							
	2 runs	Door Foamer	297416200	DOOR STOP REVERSIBLE							
cart 3	2 runs	Door Foamer	808825502	HARN ASSY DOOR BLACK FUZI UI							
	2 runs	Door Foamer	808825501	HARN ASSY DOOR WHITE FUZI UI							
	2 runs	Door Foamer	A01101301	RETAINER ASSY WITH TAPE							
cart 4	1 run	Door Foamer	297279701	EPS BLOCK							
	1 run	Door Foamer	297382300	BLOCK EPS 2.5" REV CORNER SEAL							
	1 run/week	Door Foamer	216745351	FOAM BLOCK SPACER .75X1.5X.75							
				NSF/U19'S							
										600	
Cart 1	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN							
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"							
	1 run	Door Foamer	297121202	RIVET 1/8"X.172							
	1 run/week	Door Foamer	124857-01	SCR #8-18X1/2 HI-LO BLUNT ROHS							
	1 run	Door Foamer	216917300	TAPE 2" POLY TESA 4298 IVORY							
	1 run	Door Foamer	216611100	TAPE POLY 1.00							
	1 run/week	Door Foamer	216970801	BEARING TOP HINGE GRAY							
	1 run	Door Foamer	216468700	BEZEL - LOCK							
	1 run/week	Door Foamer	216403701	HOLE PLUG FILL HOLE GREY							
	1 run	Door Foamer	297302900	BEARING DOOR REVERSIBLE							
	1 run	Door Foamer	297302801	DOOR STOP LH HIDDEN							
	1 run	Door Foamer	297302800	DOOR STOP RH HIDDEN							
	1 run	Door Foamer	297421000	SUPPORT, PAPER (PIZZA SAVER)							
	1 run	Door Foamer	297303000	U19 DOOR REINFORCEMENT							
	2 runs	Door Foamer	297045200	5/8" PERMAGUM							
Cart 2	2 runs	Door Foamer	297300301	END CAP LH							
	2 runs	Door Foamer	297300300	END CAP RH							
	2 runs	Door Foamer	297315400	ANCHOR COMMERCIAL							
	2 runs	Door Foamer	216362700	LOCK ASSY							
Cart 3	1 run	Door Foamer	297049600	REVERSIBLE LOCK BLOCK							
	1 run/week	Door Foamer	216745353	FOAM BLOCK SPACER 0.75*0.75*2.38							

The data in column named Per came from the bill of material which is the quantities of each component needed to manufacture an end product. Column titled Box Capacity Not Including Open Box stands for the amount of the boxes which could be placed on the delivery point. Total boxes/4 hours is how much boxes would be delivered by a train.

Besides the information which has already been collected from PFEP and BOM, couple of formulas were used in this spread sheet for getting the final result as well. The details of each formulas were attached in the following.

1. Capacity. Capacity is the how quantity of each part can be provided in four hours from a train. The formula was:

$$Capacity = Total\ boxes \times Box\ QTY$$

Table 9: Capacity Formula on Spread Sheet

		Color Code		Regular door							
				U19-NSF							
				Common parts							
				Services Model						800	
Cart #		Door Foamer Train			Per	Box Capacity not including open box	Total boxs/ 4 hours	Capacity	Box QTY	1st Shift	Location
		Other models									
cart 1	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN	2	1	1	=H7*J7	9000	7400	R9R22
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"	3	1	1	20160	20160	17760	R7E10
	1 run	Door Foamer	297213300	SPRING CLIP	1	1	1	4000	4000	3200	R4N11
	1 run	Door Foamer	808509901	TAPE 2 IN MASKING 3M 201 PLUS	0.076	1	1	1320	1320	1259	R8A11
	1 run	Door Foamer	129664	TAPE FIL 1" 60 YD RL 3M 8915	0.203	1	1	1980	1980	1817	R9L31
	1 run	Door Foamer	216859400	TAPE FLAT BACK 1.00 X 60 YD	0.076	1	1	1980	1980	1919	R9J33
	1 run	Door Foamer	216578900	VENT TAPE 2.00X4.500	1	2	1	2284	2284	1484	R8C10
	1 run	Door Foamer	297215001	FOAM FLAPPER	1	2	1	4000	4000	3200	R9F30
	1 run	Door Foamer	216970802	BEARING TOP HINGE	1	1	1	5000	5000	4200	R3Q20
	1 run	Door Foamer	297007500	CLIP EVAPORATOR	1	1	1	5000	5000	4200	R9E34
	1 run	Door Foamer	297415900	REVERSIBLE BEARING DOOR	1	3	2	3200	1600	2400	R9D30
	1 run	Door Foamer	297366011	SHIELD LOCK ARC DOOR	1	3	4	2000	500	1200	R6L51
	1 run	Door Foamer	240537301	ANCHOR SCREW #10	2	1	4	4000	1000	2400	R5H11
	1 run	Door Foamer	297034200	HANDLE RECESSED WHITE	1	1	2	1900	950	1100	R9D30
	2 runs	Door Foamer	297318600	LOCK ASSY UPRIGHT	1	7	5	1250	250	450	R3H31

2. 1st shift. The most important data is 1st shift which stands for the surplus after 4 hours production on door assembly line. The number 800 hereby stands for the output of lid in 4 hours. The formula of 1st shift was shown below.

$$1st\ shift = Capacity - 800 \times per$$

Table 10: 1st Shift Formula on Spread Sheet

		Color Code		Regular door							
				U19-NSF							
				Common parts							
				Services Model						800	
Cart #		Door Foamer Train			Per	Box Capacity not including open box	Total boxes/ 4 hours	Capacity	Box QTY	1st Shift	Location
		Other models									
cart 1	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN	2	1	1	9000	9000	=I7-(K$4*$F7)	R9R22
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"	3	1	1	20160	20160	17760	R7E10
	1 run	Door Foamer	297213300	SPRING CLIP	1	1	1	4000	4000	3200	R4N11
	1 run	Door Foamer	808509901	TAPE 2 IN MASKING 3M 201 PLUS	0.076	1	1	1320	1320	1259	R8A11
	1 run	Door Foamer	129664	TAPE FIL 1" 60 YD RL 3M 8915	0.203	1	1	1980	1980	1817	R9L31
	1 run	Door Foamer	216859400	TAPE FLAT BACK 1.00 X 60 YD	0.076	1	1	1980	1980	1919	R9J33
	1 run	Door Foamer	216578900	VENT TAPE 2.00X4.500	1	2	1	2284	2284	1484	R8C10
	1 run	Door Foamer	297215001	FOAM FLAPPER	1	2	1	4000	4000	3200	R9F30
	1 run	Door Foamer	216970802	BEARING TOP HINGE	1	1	1	5000	5000	4200	R3Q20
	1 run	Door Foamer	297007500	CLIP EVAPORATOR	1	1	1	5000	5000	4200	R9E34
	1 run	Door Foamer	297415900	REVERSIBLE BEARING DOOR	1	3	2	3200	1600	2400	R9D30
	1 run	Door Foamer	297366011	SHIELD LOCK ARC DOOR	1	3	4	2000	500	1200	R6L51
	1 run	Door Foamer	240537301	ANCHOR SCREW #10	2	1	4	4000	1000	2400	R5H11
	1 run	Door Foamer	297034200	HANDLE RECESSED WHITE	1	1	2	1900	950	1100	R9D30
Cart 2	2 runs	Door Foamer	297318600	LOCK ASSY UPRIGHT	1	7	5	1250	250	450	R3H31
	2 runs	Door Foamer	297385600	CURVE DOOR REINFORCEMENT RH/LH	1	5	5	2000	400	1200	R7F51
	2 runs	Door Foamer	297385602	REINFORCEMENT CURV BTM LH	1	4	4	1800	450	1000	R4T10

After imported the known data, Microsoft excel would calculate the rest of data per all the formula listed above automatically. Therefore, Table 11 was the parts number calculated for door foamer delivery train.

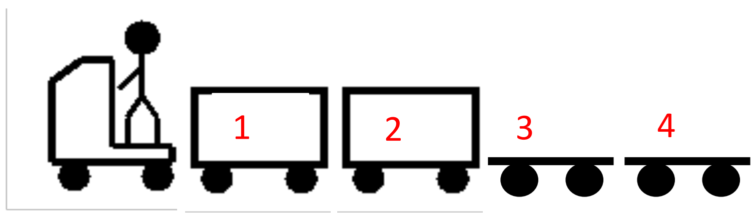
Table 11: Final Part List for Door Foamer Delivery Train

		Color Code		Regular door							
				U19-NSF							
				Common parts							
				Services Model						800	
Cart #		**Door Foamer Train**			Per	Box Capacity not including open box	Total boxs/ 4 hours	Capacity	Box QTY	1st Shift	Location
				Other models							
	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN	2	1	1	9000	9000	7400	R9R22
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"	3	1	1	20160	20160	17760	R7E10
	1 run	Door Foamer	297213300	SPRING CLIP	1	1	1	4000	4000	3200	R4N11
	1 run	Door Foamer	808509901	TAPE 2 IN MASKING 3M 201 PLUS	0.08	1	1	1320	1320	1259	R8A11
	1 run	Door Foamer	129664	TAPE FIL 1" 60 YD RL 3M 8915	0.2	1	1	1980	1980	1817	R9L31
	1 run	Door Foamer	216859400	TAPE FLAT BACK 1.00 X 60 YD	0.08	1	1	1980	1980	1919	R9J33
cart 1	1 run	Door Foamer	216578900	VENT TAPE 2.00X4.500	1	2	1	2284	2284	1484	R8C10
	1 run	Door Foamer	297215001	FOAM FLAPPER	1	2	1	4000	4000	3200	R9F30
	1 run	Door Foamer	216970802	BEARING TOP HINGE	1	1	1	5000	5000	4200	R3Q20
	1 run	Door Foamer	297007500	CLIP EVAPORATOR	1	1	1	5000	5000	4200	R9E34
	1 run	Door Foamer	297415900	REVERSIBLE BEARING DOOR	1	3	2	3200	1600	2400	R9D30
	1 run	Door Foamer	297366011	SHIELD LOCK ARC DOOR	1	3	4	2000	500	1200	R6L51
	1 run	Door Foamer	240537301	ANCHOR SCREW #10	2	1	4	4000	1000	2400	R5H11
	1 run	Door Foamer	297034200	HANDLE RECESSED WHITE	1	1	2	1900	950	1100	R9D30
	2 runs	Door Foamer	297318600	LOCK ASSY UPRIGHT	1	7	5	1250	250	450	R3H31
	2 runs	Door Foamer	297385600	CURVE DOOR REINFORCEMENT RH/LH	1	5	5	2000	400	1200	R7F51
Cart 2	2 runs	Door Foamer	297385602	REINFORCEMENT CURV BTM LH	1	4	4	1800	450	1000	R4T10
	2 runs	Door Foamer	297385603	REINFORCEMENT CURVE TOP LH	1	2	4	2000	500	1200	R5M11
	2 runs	Door Foamer	297385601	CURVE DOOR REINFORCEMENT RHTOP	1	3	4	2000	500	1200	R9N30
	2 runs	Door Foamer	297416200	DOOR STOP REVERSIBLE	1	2	5	1980	396	1180	R5R11
	2 runs	Door Foamer	808825502	HARN ASSY DOOR BLACK FUZI UI	1	39	11	825	75	25	Warehouse
cart 3	2 runs	Door Foamer	808825501	HARN ASSY DOOR WHITE FUZI UI	1	1	11	825	75	25	R3J10
	2 runs	Door Foamer	A01101301	RETAINER ASSY WITH TAPE	1	3	8	880	110	80	R7H21
	1 run	Door Foamer	297279701	EPS BLOCK	2	1	2	3000	1500	1400	Oven 4
cart 4	1 run	Door Foamer	297382300	BLOCK EPS 2.5" REV CORNER SEAL	2	1	2	3000	1500	1400	Oven 4
	1 run/week	Door Foamer	216745351	FOAM BLOCK SPACER .75X1.5X.75	9	1	1	55680	55680	48480	R4P20
				NSF/U19'S							
										600	
	1 run	Door Foamer	297197500	SCR FH #8-16X.750 TYPE P TWIN	2	1	1	9000	9000	7800	R9R22
	1 run	Door Foamer	216403300	TAPE VENT "1.25 X 1.25"	3	1	1	20160	20160	18360	R6P11
	1 run	Door Foamer	297121202	RIVET 1/8"X.172	1	1	1	30000	30000	29400	R9D10
	1 run/week	Door Foamer	124857-01	SCR #8-18X1/2 HI-LO BLUNT ROHS	4	0.5	1	12500	12500	10100	R9N32
	1 run	Door Foamer	216917300	TAPE 2" POLY TESA 4298 IVORY	0.3	1	1	1980	1980	1797.12	R9H30
	1 run	Door Foamer	216611100	TAPE POLY 1.00	0.08	1	1	3960	3960	3914.28	R9H31
	1 run/week	Door Foamer	216970801	BEARING TOP HINGE GRAY	1	1	1	5000	5000	4400	R7N11
Cart 1	1 run	Door Foamer	216468700	BEZEL - LOCK	1	1	1	4000	4000	3400	Warehouse
	1 run/week	Door Foamer	216403701	HOLE PLUG FILL HOLE GREY	1	1	1	7000	7000	6400	R1H34
	1 run	Door Foamer	297302900	BEARING DOOR REVERSIBLE	1	1	1	1600	1600	1000	R9F15
	1 run	Door Foamer	297302801	DOOR STOP LH HIDDEN	1	1	2	640	320	40	R1G25
	1 run	Door Foamer	297302800	DOOR STOP RH HIDDEN	1	1	2	640	320	40	R1H22
	1 run	Door Foamer	297421000	SUPPORT, PAPER (PIZZA SAVER)	9	11	6	6000	1000	600	R6B10
	1 run	Door Foamer	297303000	U19 DOOR REINFORCEMENT	1	1	2	800	400	200	R7R20
	2 runs	Door Foamer	297045200	5/8" PERMAGUM	2	4	2	1280	640	80	R4J10
	2 runs	Door Foamer	297300301	END CAP LH	1	3	20	600	30	0	R8L51
Cart 2	2 runs	Door Foamer	297300300	END CAP RH	1	3	20	600	30	0	R7B11
	2 runs	Door Foamer	297315400	ANCHOR COMMERCIAL	2	1	3	1500	500	300	R3E11
	2 runs	Door Foamer	216362700	LOCK ASSY	1	2	3	600	200	0	R3J10
Cart 3	1 run	Door Foamer	297049600	REVERSIBLE LOCK BLOCK	1	0.5	2	1000	500	400	Oven 4
	1 run/week	Door Foamer	216745353	FOAM BLOCK SPACER 0.75*0.75*2.3	9	1	1	33408	33408	28008	Oven 4

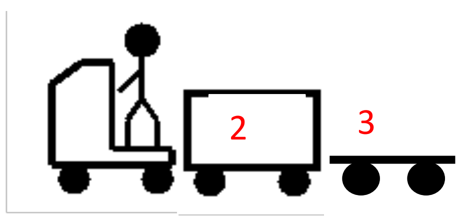
According to this final part list, the trial would be conducted to decide the amount of carts that would be needed per train. Besides the amount of the carts, the trial need decided the location of each part on the cart following the principles of ergonomics. From the final part list, the quantity of one box of some of the parts can fulfill more than the need of 4 hours production. Instead of delivering the actual amount part, the whole box of parts which can used for more than 4 hours would be concentrated on one or two carts and sent only once a shift. The sketches of the door foamer train were showed as following.

1. The door foamer train for other models:

   1st run:

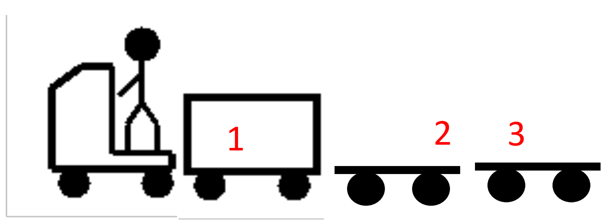


   2nd run:

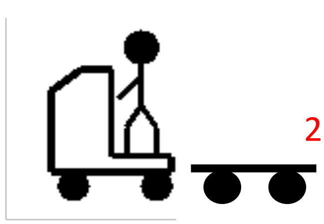


2. The door foamer train for NSF/u19'S:

   1ST run:



   2nd run:



The train delivery schedule was shown in Figure 8. This schedule was used as a reference for material handler.

Door Foamer	Time	W	TH	F	M	T
	10:00AM	2nd Plain Trian	2nd Plain Trian	2nd Plain Trian	1st U19 Train	2nd Plain Trian
1st shift	2:30PM	1st U19 Trian	1st Plain Trian(2:00PM)	1st Plain Trian	1st Plain Trian	1st U19 Trian
	6:00PM	2nd U19 Trian	2nd Plain Trian	2nd Plain Trian	2nd U19 Train	2nd U19 Trian
2nd shift	10:00PM	1st Plain Trian	1st Plain Trian	1st Plain Trian	1st Plain Trian	1st Plain Trian
	11:00PM					
3rd shift	N/A	N/A	N/A	N/A	N/A	N/A

Figure 10: Train Delivery Schedule

Summary

The actual data collected in the project was presented in this chapter. The details of analyzing the data were shown in this chapter to support the final results and implementation. Next chapter will mainly state the results, conclusion and recommendations.

Chapter V: Results, Conclusion, and Recommendations

Introduction

In this chapter, the final results will be stated by answering each project question. A conclusion will be given to show the accomplishment of this project. At end, recommendations will be given to support future work.

Results

1. What kind of material handling system would be designed to improve efficiency and reduce material wastage?

   Answer: Train delivery system. After the train delivery system was applied to the door foamer line, it greatly reduced double handling, which happened during material transferring.

2. How can the material handling move larger loads per trip than the current system?

   Answer: Compared with forklift which only delivery one pallet a time, the train organized the cart in maximum. The new delivery system not only increased the loads per trip but decreased the trip per shift relevantly.

3. How can the material handling system reduce line side WIP inventory?

   Answer: After categorized components, the amount of parts would be delivered only when the stock on the assembly was low. Delivery schedule is not fixed which will be more controllable for both the supervisor and material handler.

4. How can the material handling achieve this with reduced fork lift truck movement?

   Answer: Train delivery system was applied on door foamer line first. Furthermore, it would be applied on different assembly lines step by step and reduce all the fork lift truck in the end.

Besides these, MEP saved the cost of forklift maintenance and material handling labor as well. From Table 13, there is $52,932.66 was saved per position in travel pallet casters and MEP material handling savings annually. As for maintenance part, the annual maintenance cost was $63,710.00 which was saved by new train system. Therefore, MEP mainly saved $ 169,575.32 annually at this stage. The detail information was shown as following.

Table 12: Capstone Project Saving

MEP project savings with ABC Company - 2015			
Project #	**Description**	**Anualized**	**Notes**
N/A	Travel pallet Casters	$52,932.66	1 Position elimination- Travel pallet drive 2
4843	MEP material handling savings	$52,932.66	1 Position elimination-Small parts
5236	Forklift Maintenance Savings	$63,710.00	
	Total	$169,575.32	

Conclusion

This study recommended a methodology-Material Excellence Program (MEP) to improve the material handling situation of Company ABC. The previous material deliver system caused waste and time delay mainly due to the unscheduled delivery time and unfixed parts number. Demand of the parts amount for the assembly line was set by the supervisor subjectively and because the parts piled up at the line floor which would cause space waste. It took more than 2 hours to complete the delivery process for the individual part of the door foamer line before. After the implementation of train system, the picking job and delivery job were distributed to individual workers. Although the picking time kept in the same level, team workers was more easily to track the part which needed to be reloaded because of applying the subsystems. Therefore, the load time was reduced greatly relevantly. The form shown on appendix B was designed for supervisor to tracking the train schedule in the beginning of the implementation which helped them get prepare before the train's coming.

Recommendations

The recommendations flowing from the work carried out in this project are:

1. Some parts of information from PFEP database are out of date. It is high time to maintenance and update the whole database for the sake of a better project result.
2. It is highly recommend to train everyone on how the system will work and on their role in the process before schedule the train delivery system. A brief presentation could be developed to explain the process of new replenishment system. Created what-of scenarios to help team members understand their roles and the decision-making process. The training should be kept to focus on operating this system instead of being an expert.

3. Communication with outsources company was extremely important to keep project under control. It is suggested to order tuggers and carts ahead of implementation to make the project work more smoothly.

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Appendix A: Interview Questionnaire

Name_______________ Job Title_______________

1. Have you ever experienced the situation of lacking of component to assemble?
   a. If yes, how often and how long did you wait for the material coming?

2. After implement the new delivery system, how often did you expected the material been delivery per shift?

3. Where did you want the material handler place the parts in your convenience?

4. Were you lacking of racks to hold the material buffer? If yes, what kind of racks are you prefer to use?

5. Any questions or suggestions regard this project?

Interviewer: ____________ Date___________

Appendix B: Door Foamer Train Schedule

Train No.	1st Plain Train	2nd Plain Train	
	1st U19&NSF Train	2nd U19&NSF Trian	
Door Foamer		**MONDAY**	
		Train No.	**Added Parts**
1st shift	10:00AM		
	2:30PM		
2nd shift	6:00PM		
	10:00PM		
	11:00PM		
3rd shift			
Door Foamer		**TUESDAY**	
		Train No.	**Added Parts**
1st shift	10:00AM		
	2:30PM		
2nd shift	6:00PM		
	10:00PM		
	11:00PM		
3rd shift			
Door Foamer		**WEDNESDAY**	
		Train No.	**Added Parts**
1st shift	10:00AM		
	2:30PM		
2nd shift	6:00PM		
	10:00PM		
	11:00PM		
3rd shift			
Door Foamer		**THURSDAY**	
		Train No.	**Added Parts**
1st shift	10:00AM		
	2:30PM		
2nd shift	6:00PM		
	10:00PM		
	11:00PM		
3rd shift			
Door Foamer		**FRIDAY**	
		Train No.	**Added Parts**
1st shift	10:00AM		
	2:30PM		
2nd shift	6:00PM		
	10:00PM		
	11:00PM		
3rd shift			